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Industrial Application of Induction Heated System

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Abstract

A high frequency resonant mirror inverter based induction-heated device has been evolved with helical formed heating coil in its primary. To reduce the pores and skin effect loss & proximity loss, the heating coil is manufactured from litz twine. The coil inductance & a.c resistance were decided the usage of analytical method below on load situations. With the specific secondary metallic gadgets in its secondary the determined values of inductance & a.c resistance have been found to alternate substantially. For industrial programs stainless nevertheless is preferred due to its excessive permeability and resistivity. The lab prototype of induction heated gadget is experimented with water as fluid & stainless nevertheless plates as secondary metal object and for exceptional frequencies efficiencies were acquired. eventually to decide the load shape the system is examined with single layer, double layer & triple layer metal sheets made of different metallic mixtures.

Keywords : *reflect inverter, litz cord, a.c. resistance, metallic item, system performance*

INTRODUCTION

Induction heating is a contactless method of generating warmth power in a magnetically conductive fabric with the aid of generating both eddy modern-day losses and hysteresis losses in the work piece from an outside variable excessive-frequency PWM inverter. The excessive-frequency magnetic field is typically set up by a magnetic coil wrapped around the paintings piece or held parallel to the surface of the paintings piece. Resonant inverters are widely used for induction heating over extensive frequency levels from four kHz to 500 kHz (pal, Sadhu and Chakrabarti, 2006). The inverter operating frequency selected for a specific utility is based on the intensity of warmth penetration and on energy conversion efficiency (Dawson & Jain, 1991).

- material conductivity:
  The conductivity of the fabric of the metal floor has a direct impact at the go with the flow of eddy present day. The higher the conductivity of the material the bigger can be the glide of eddy currents on the surface.
- Permeability of the fabric:
  Permeability is the property of a material describing the convenience with which it could give passage to magnetic flux. For non-ferrous metals together with copper, brass, aluminum and so forth.and for austenitic stainless steels, the permeability is almost similar to that of loose space i.e. the relative permeability can be very close to unity. For ferrous metals, however, the cost of relative permeability might be quite high, of the order of numerous hundred. The value of μ has a great affect at the value of the prompted eddy contemporary.
- operating frequency:
  The response to eddy contemporary is substantially laid low with the frequency selected. Happily, however, this is an item which can be without difficulty controlled.

The developed scheme

The electromagnetic induction based fluid heating appliance using the excessive-frequency series resonant inverter and its associated gadget manipulate technology appears to attract hobby in clinical,

chemical, mechanical and consumer warmness electricity utilization in the pipeline machine (Sadhu, P. k., Chakrabarti, R. N., Chowdhury, S. P., 2008). Direct fluid heating based on electromagnetic induction principle can be accomplished in approaches viz. pores and skin effect heating in wall-floor of pipeline and bundle-in-pipeline inner eddy modern heating. The latter approach seems an attractive idea integrated on this topology. The eddy currents are prompted in flow through steel bundle with a large number of heating surface included into the non-steel pipeline by using means of an outside working-coil fed from a excessive-frequency series resonant inverter operated via PWM scheme and whose 'OFF' time is more or much less stored consistent for specific set temperature while the 'ON' time is multiplied for faster upward thrust in temperature. Fig.1 suggests a schematic system configuration of Induction Heating system

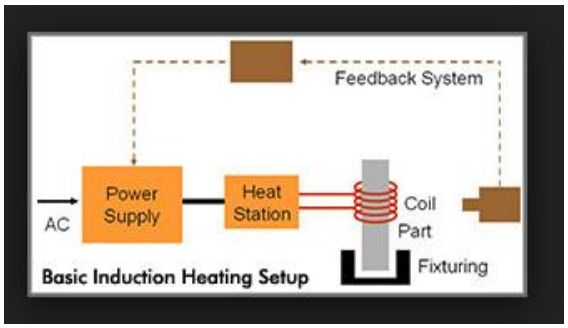

Fig 1: *Induction setup*

The fluid-heating appliance used within the pipeline system is composed of a diode rectifier without smoothingfilter out so one can operate at energy element that's close to team spirit. For harmonic modern repayment, a modern-fedchanged 1/2 bridge kind collection load resonant replicate inverter with a variable frequency variable strength controlis provided.

A specifically-designed electromagnetic induction fluid heating assembly with a metallic package toattain eddy modern-day heating within the pipe line device is integrated into the non-steel vessel. The operatingcoil is wrapped around for generating excessive-frequency flux. This appliance is noticeably appropriate for fluid heat transfer and delivery processing flowers in addition to heat strength garage and heat change processing because ofsmooth, compact, green and clever reaction. From practical point of view, the above appliance appears cost effective for induction-heated boiler, evaporator, hot water supplier and splendid heating unit inside the pipeline system.

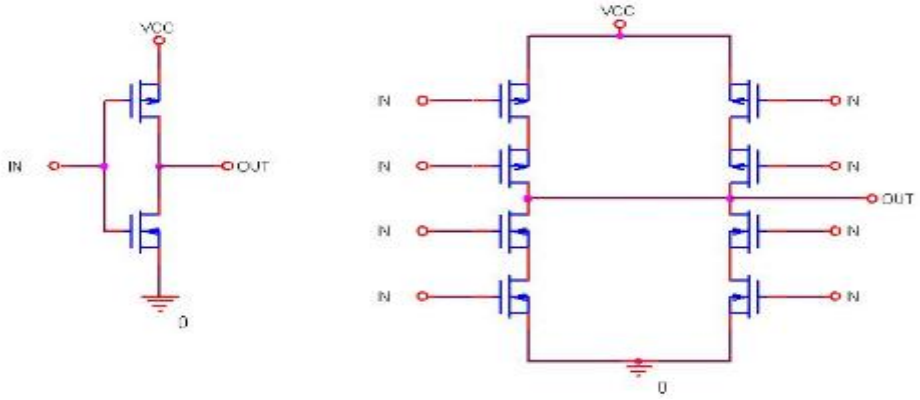

Fig 2

Mirror Circuit for (a) Inverter and (b) Generic two input logic gate

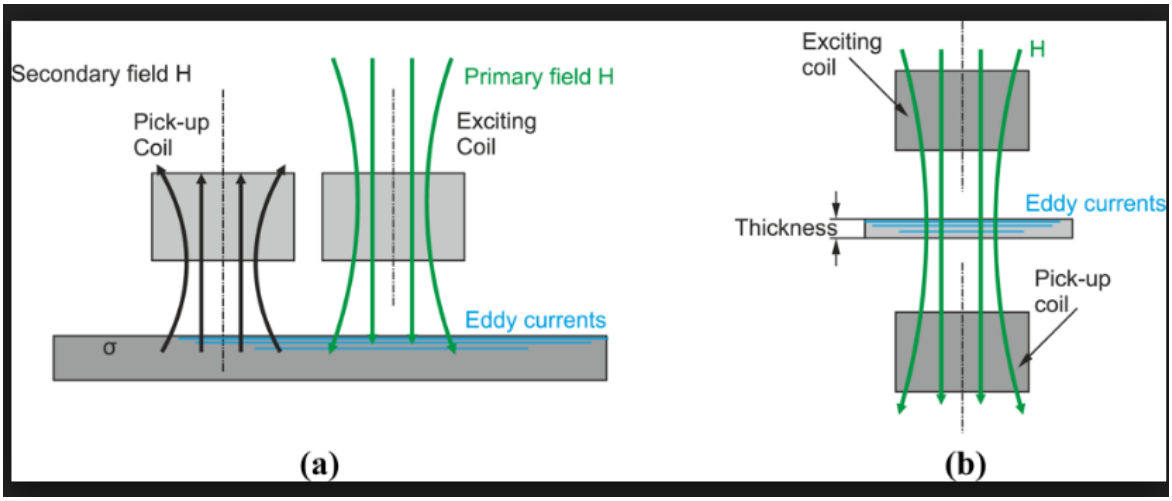

Fig 3: *eddy current heated metallic package*

Reflect Inverter Based Totally Machine

Now, the single factor MN is stretched as shown in Fig. three. The fundamental operating of this configuration is very simple(Sadhu et al., 2005). The non-easy D.C voltage is to be had across A & B points within the above-referred tocircuit. As explained there, the generated alternating current via the NM bar can even float thru theinduction heating running coil 'L' so that you can generate alternating magnetic flux because its miles connected inseries.

Fig.2 indicates an in particular designed eddy current heated metallic bundle advanced that is tightlyincorporated into the nonmetallic vessel or tank in the pipeline. The routinely processed skinny stainless steellayer package deal with many spots and fluid channels for cylindrical induction-heated meeting is tested inFig.3.

Strength deliver unit for the prevailing scheme

The voltage to be had at the premises of business plants in India is 440 V, 50 Hz, three-□ ,four-W. For the prevailingscheme the above electricity deliver is rectified to present d.c. output voltage by full bridge rectifier. earlier than feeding tothe inverter circuit, this d.c. output is filtered thru a non-smoothing L-C clear out circuit to eliminate harmonics.Harmonics also are generated all through inverter operation & the identical non-smoothing filter out additionally works as a high pass clear out to avoid harmonic injection returned into the supply gadget bus bar.

Implementation of triggering circuit

The hardware implementation for series resonant inverter with IGBTs has the disadvantage of drawing veryhigh peak cutting-edge from the supply in addition to the circuit constraints. Insertion of phase difference between triggering of the 2 IGBT is likewise difficult to implement through hardware method. Conversely, generating rectangular pulses with required section difference is a comparatively clean mission with the assist of 8085 microprocessor.

Design of the heating coil of the inverter

The induction coil layout is one of the maximum critical components of an induction heating gadget. The coil is acustom layout to offer the work piece or part of it the proper heating pattern, maximize efficiency of the induction heating energy supply's load matching machine. A salient trouble within the layout of high- frequency inductors and transformers is eddy-contemporary effects

in windings (Ferreira, J. A., 1994). Those effects include skin-impact lossesand proximity impact losses. each results can be controlled by means of the use of litz cord-conductors made from a couple of personally insulated strands twisted or woven collectively. from time to time the time period litz cord is reserved for conductors built in step with a cautiously prescribed sample, and strands sincerely twisted together are referred to as bunchedcord (Cheng, okay. W. E. & Evans, P. D., 1994). The time period litz wire may be used for any insulated grouped strands.in the gift paintings the litz wire is used as a heating coil in a high frequency replicate inverter fed induction heatedmachine. so that you can remove the problems because of the penetration of high frequency present day, the number one heatingcoil is fabricated from litz twine. As cited earlier litz wire accommodates of a couple of strands of finer wires having aninner conductor and an outer insulating layer. The strands are twisted symmetrically with recognize to the centerline of the wire in the sort of way that the modern-day density distribution within the twine will become uniform. Three or more such litz wires are twisted to form a composite litz twine. The composite litz wires are suitable for the use in a excessive - frequency coil. However, the effectiveness of a litz twine relies upon on the choice of its wide variety of strands and the size of every strand. In flip, they bring about distinctive inductance values. For an induction heating reason, higher the inductance better is the heat era. However, growth in deliver frequency the contemporary penetration in litz cord reduces.

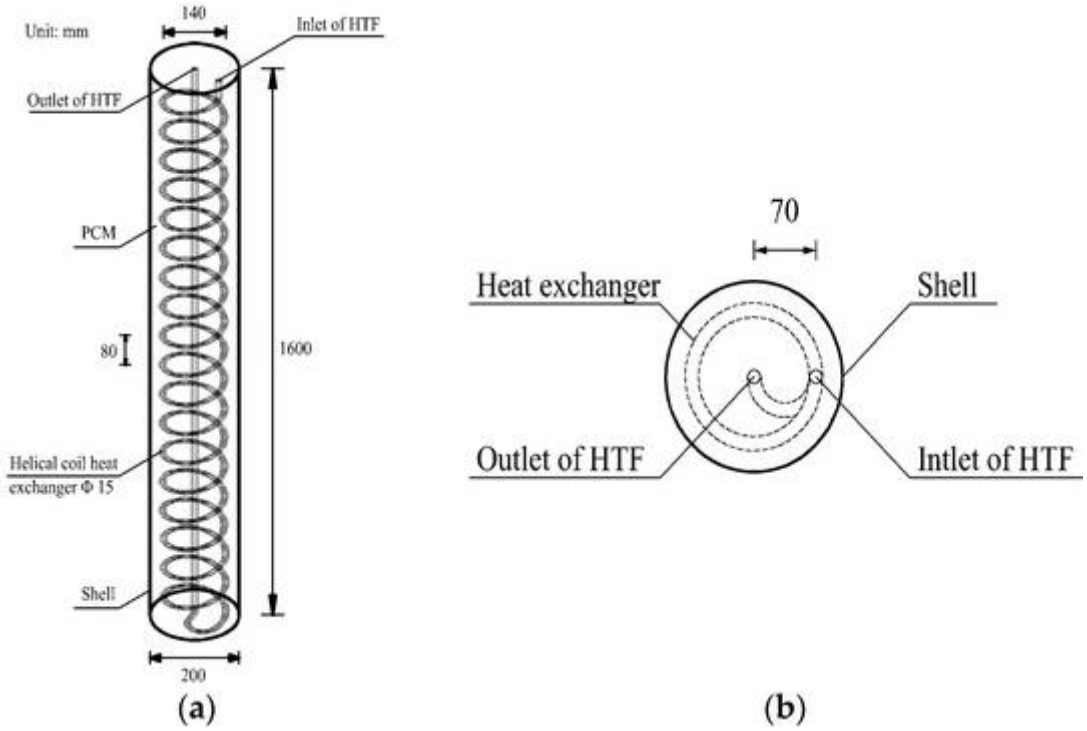

Fig 4: *Schematic diagram of helical coil (a) internal dimension and (b) overall view*

Hardware Prototype of the prevailing Scheme

The distinct photographs of the existing experimental set-up are proven in Fig. 5 and Fig. 6

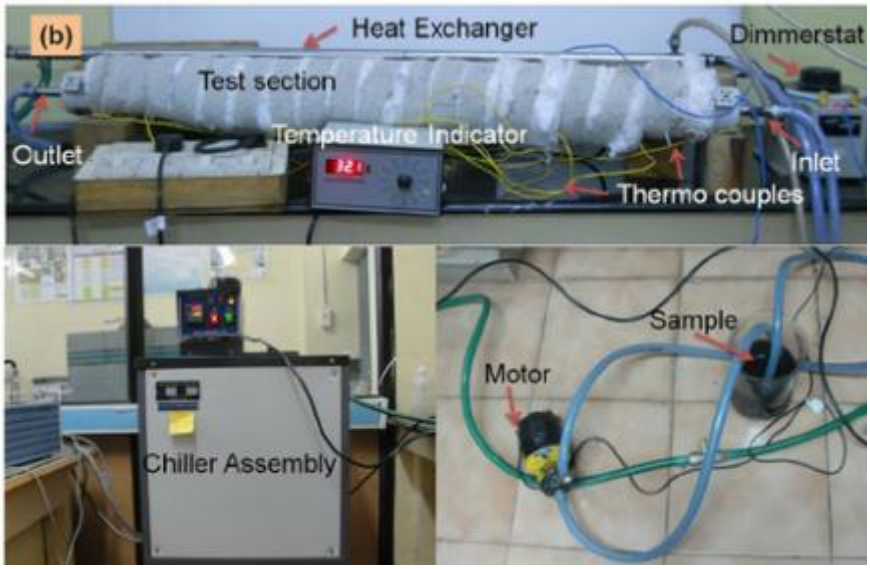

Fig 5: *Experimental set-up along with different measuring instruments.*

Fig 6: Set-up for industrial plant

Production of Secondary metal item with replicate Inverter

It is usually proper that the more high priced the fabric is the greater high priced is to construct the secondarymetal item for the induction heated system. The overall performance of the device relies upon now not best upon the typeof metallic but additionally upon the quantity of steel used inside the object. However, the other key factors that decide thefee of construction and the performance of the item are as underneath:

- The conductivity of the metal.
- The thickness of the object partitions.
- The surface region of the steel item.
- The magnetic property of the metal used inside the machine.
- Layers of different metals used in the secondary aspect

RESULT

Parameters of primary heating coil in on-load circumstance have been decided with secondary steel objects. For commercial utility of induction heated gadget, stainless-steel is desired as secondary steel item and therefore, the equivalent coil inductance & a.c resistance had been utilized in designing the litzcord. From the point of view to preserve the strand diameter of the number one heating coil ofthe induction heater as excessive as feasible for commercial applications, the strand length with 24 AWG is preferred. due to the inherent advantages, induction heated machine primarily based on high frequency replicate inverter are similarly effective for industrial programs as it's miles for domestic equipments. To reduce the pores and skin effect and proximity effect losses, the heating coil is made from litz wire. However, choice of a litz wire creation is difficult and computation of a.c resistance, inductance of a litz wire is complex. within the present paper, an attempt is made to design a litz twine for business application. Inductance is calculated for 4 one-of-a-kind litz wires, 1-layer-4-stranded, 2-layer-7-stranded, 3-layered-19-stranded and 4-layered-37-stranded.From the study of a.c resistance dedication, it has been noticed that range of twist effects in less value of a.c resistance but on the equal time inductance is reduced. but, maintaining in thoughts the physical constraints of constructing a twisted litz wire, one hundred numbers of twists in keeping with toes changed into taken into consideration. Furthermore, a.c resistances have been discovered to be growing with the growth in running frequency. therefore, a decrease price of working frequencycan be preferred.

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